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ABSTRACT

This is a report of a program aimed at the demonstration, tests, and evaluation of the educational and economic effectiveness of PLATO IV computer-based education as implemented in several geographically dispersed military training sites. It also describes a technical program aimed at increasing the cost effectiveness of the PLATO system. During this reporting period efforts of the Military Training Command (MTC) and of the PLATO Educational Evaluation and Research (PEER) groups were directed towards data gathering, researching, and preparing reports describing characteristics of the Advanced Research Projects Agency (ARPA)/PLATO project. The reports, in various stages of preparation, are: (1) Reliability of CBE Systems, (2) An Assessment of Lesson Review as a Formative Evaluation Tool, (3) PLATO IV Terminal Peripheral Devices, (4) TUTOR Training: Lessons Learned, (5) An Overview of Chanute Lessons, (6) A Survey of Chanute Lesson Development Techniques, (7) PLATO Courseware Development Procedure, and (8) Locus of Control in Computer-assisted Instruction. Various data and brief descriptions of smaller projects are presented. (Author/DAG)

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# SEMI-ANNUAL REPORT

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## DEMONSTRATION AND EVALUATION OF THE PLATO IV COMPUTER-BASED EDUCATION SYSTEM

(Computer-based Education for a Volunteer Armed Service Personnel Program)

For the Period

July 1, 1976 - December 31, 1976

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June, 1977

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PREFACE

This report under Contract DAHC 15-73-C-0077 describes a program aimed at the demonstration, test and evaluation of the educational and economic effectiveness of the PLATO IV computer-based education as implemented in several geographically despersed military training sites. It also reports on a technical program aimed at increasing the cost effectiveness of the PLATO system.

ARPA support for the technical program ended in August 1976. Reporting of progress under this contract was substantially complete when the preceeding technical report (for the period 1/1/76 - 6/30/76) was published in August 1976. Sections two through six of this current document brings the reporting up to date as of the termination of the technical part of the program.

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## 1.1 MTC ACTIVITIES

### 1.1.1 OVERVIEW

During this reporting period virtually the whole effort of the MTC and PEER groups was directed towards data gathering, researching, and preparing reports describing characteristics of the ARPA/PLATO project and answering the question "Under what conditions can CBE make a cost-effective contribution to the instructional needs of the services?" Preparation of all the major reports has begun and publication of several reports has been completed. Report status information is provided in the next section of this report.

Efforts to summarize lessons learned and to critique project reports from Sheppard AFB and Chanute AFB have been held up pending receipt of reports from those projects. We have been advised that the Chanute reports will be ready by middle or late February 1977. Other data gathering has gone well. Interviews have been conducted at Chanute in order to provide additional background about the activities there. Staff at other sites have been interviewed by telephone. Several questionnaires have been constructed, administered, and the responses analyzed.

### 1.1.2 REPORT STATUS

During this period, several reports have been completed and are now published or nearly ready for publication. Abstracts of these reports are given below with indications of their publication status.

Reliability of CBE Systems by R. A. Avner (in preparation). General procedures for assessing the accessibility of CBE systems have

been developed based on experience with the PLATO CBE system. A study of user tolerance for system unreliability has been completed and is the basis for a set of guidelines for assessing reliability of any operating CBE system. Data conforming to these guidelines is being collected for the total PLATO system and will be included in a final report.

An Assessment of Lesson Review as a Formative Evaluation Tool by E. Call-Himwich (published). For the last three years the MTC PLATO support group has been experimenting with the development of a number of formalized techniques for assisting authors in writing instructionally effective courseware. These methods, collectively referred to as "lesson reviewing", vary widely depending on individual authors' needs. Basically, however, a lesson review is a set of comments about the lesson ranging from alternative instructional strategy suggestions to grammatical corrections, from content accuracy to punctuation (see Lesson Review, MTC report #3, 1976, L. Francis, M. Goldstein, and E. Call-Himwich for examples and complete descriptions of review techniques).

This report describes the evolution of the lesson review process and discusses review effectiveness in terms of resulting lesson revision and author training. The report also details a number of recommendations for improving review effectiveness in the future. The following areas:

---reviewer characteristics
---reviewer/author relationship
---review content/format

are emphasized. Some specific recommendations are that the reviewer should be on-site, that the reviewer's actual or perceived authority should be equal to the author's, and that the reviewer and author should

reach either a contractual or lesson formalized agreement about the purpose of the review and about what specific feedback each expects.

PLATO IV Terminal Peripheral Devices by L. Francis (published). This report reviews the experience of users of three PLATO IV terminal peripheral devices. User perceptions of reliability as well as effective modes of use of the touch panel, random-access audio, and microfiche projection system are indicated. These devices, when attached to a PLATO IV terminal, serve to expand the types of input and output which can be managed by the terminal. During 1972 - 1976 these three devices were manufactured and delivered to PLATO users for the first time. Few guidelines and no previous experience lighted the path for the authors who attempted to employ these new devices to instruct their students. In this report are collected some of the empirical knowledges and results stemming from this initial implementation.

For each peripheral device, this study reports the operating characteristics and their adequacy, the efforts and skills required to use the device, and alternatives which were considered. Also included are managerial considerations and some brief comparative data. As an evaluation report designed to aid decision makers, it contains no instructions detailing how to acquire, maintain, or operate these devices.

Main conclusions were that the touch panel is generally reliable, the slide selector is adequate but good microfiche are hard to produce, and that early audio devices are barely satisfactory (and too few data are available for new models). It is noted that on-site testing and maintenance are needed for reliable performance and that authors wasted time and money trying to take shortcuts.

JTOR Training: Lessons Learned by L. Francis (published). The MTC group created and taught the first formal author training course for the TUTOR programming language and the use of the PLATO system. The course was used over a period of three years to train approximately 100 authors who spent two to three weeks at the Computer-based Education Research Laboratory. In general, the new authors had little previous experience with computers or programmed instruction; however, many were classroom instructors.

Thirteen cognitive and affective principles guided the creation of the author course; five were posited originally, and the rest were formulated based on experience derived from teaching the course. This report contains a statement of the principles and a description of thier implementation, including many examples from course materials. It also recounts the highlights and turning points of the author training course, reviews the basis for its modification, and examines the dilemmas encountered in teaching new authors to prepare computer-based instruction materials. Techniques for resolving some of these dilemmas are suggested.

The MTC training course was evaluated by examining the experience of users outside of MTC. The opinions and recommendations of these outside groups suggest that they found the materials valuable and effective This report is directed to instructors of new authors, developers of author training materials, and managers of computer-based instruction development centers.

"Some Aspects of Project Establishment and Management" by H. A. Himwich (completed). This is the first of three chapters dealing with the Service Test of PLATO at the Aberdeen Proving Grounds. The report analyzes

and summarizes the highlights from that project with a special emphasis on the generalizable lessons learned from Aberdeen's experience. Critical decisions and turning points in the project are elucidated. This chapter also supplements the brief project history given in the Aberdeen Final Report.

"Analysis of Aberdeen Courseware" by E. Call-Himwich (completed). This is the second chapter of the document described above. It examines the six Aberdeen lessons for which most evaluation data are presented, details their characteristics, and provides a basis for evaluating the results reported in the Aberdeen Final Report. Both of the above chapters will be published as soon as the third chapter, which comments and critiques the final report, is completed.

An Overview of Chanute Lessons by J. Klecka (in final preparation). A survey of current lesson development was considered essential to determine the quality and effectiveness of instructional material produced on the PLATO IV computer-assisted instruction system. The trial period lasted for several years. Both civilian and military personnel developed the lessons, in consultation with the Military Training Centers group at the Computer-based Education Research Laboratory, for the Defense Advanced Research Projects Agency. Eight representative lessons were selected by a Chanute staff member. Then an evaluator prepared in-depth reviews of each, both in the formative and summative stages. Data gathered from the individual analyses formed the basis for the final report. It indicated general trends and isolated problem areas in the instructional design. The study resulted in an assessment of the instructional effectiveness and utilization of the pedagogical capabilities of the

PLATO system in one training environment.

A Survey of Chanute Lesson Development Techniques by J. Klecka (in preparation). A survey of the process of lesson revision and development at Chanute AFB was considered important to determine its effects on the lessons and the pedagogical impact of the computer-based education materials. Eight representative lessons were selected by a Chanute staff member. Then these lessons were subjected to a series of modifications by Chanute staff members to insure their validation when used by military students. An MTC evaluator prepared an in-depth analysis of the "before" and "after" versions of each lesson to ascertain the changes and their impact. Evaluators at Chanute were given draft versions of the report for their comments which were included in the final version.

PLATO Courseware Development Procedures by W. Mahler, A. L. Misselt, R. Schell, and D. Alderman (published). This report was co-authored by an MTC staff member and staff of the Educational Testing Service. The authors met at CERL during the first half of 1976, but the final version of the report was not preapred until this reporting period. This paper report

This paper reports on a study of procedures used by 16 groups to develop courseware for the PLATO system. The common elements in the steps taken to develop usable courseware, the personnel considerations involved in this task, and factors which exerted a strong influence on the process of courseware development are described. The five stages used to describe the process are planning, production, review, validation and documentation, and implementation. Courseware characterisitcs which influence these stages are discussed. Five models of group sturcture are compared with the actual groups. The changing emphases of group

activities, the influence of the PLATO system, the personnel selection and training methods used, the relevant backgrounds and other characteristics of individuals, and the costs of courseware development are discussed. The report concludes with a summary and recommendation for further research.

Locus of Control in Computer-assisted Instruction by E. Steinberg (submitted for publication). It has been anticipated that computer-assisted instruction (CAI) can help to improve education by allowing the learner to control various instructional variables. This paper summarizes empirical studies in the published literature, and in unpublished manuscripts. Considerable variation in definitions of learner control, wide differences in research goals, and equivocal results of the limited number of studies preclude any definitive conclusions or generalizations. It is suggested that research questions be reformulated (1) to include learner as well as instructional variables and (2) to consider individualizing learner control itself.

### 1.1.3 ASSESSMENT OF STATUS

The evaluation project is behind the schedule set out originally. Several conditions contributed to the delays now being observed.

Some delayed reporting reflects only the problems of accurately predicting dates for acquiring and publishing information. Such delays can be expe-ted to be resolved by the time the whole evaluation is complete. For example, staff attrition from some military sites forced rearranged interviewing schedules in order that important data would not be lost.

In some cases, reports are substantially complete except for an important chapter. Rather than publishing the components separately, these reports are being held up until they can be published in unified form.

Other delays are not merely rearrangements of the original schedule, but are the results of situations unforeseen when the schedule was established. The following unanticipated conditions stretched resources beyond the limits required for support of the planned effort. (1) In response to changes in the objectives at several of the ARPA/PLATO sites, it became necessary for the sponsor to request modifications of on-going contracts for services at these sites. While efforts were made to anticipate effects of these changes in objectives, it is now clear that site start-up delays have meant irretrievable losses in time for CERL. Extra time made available by these delays has been used to provide more depth to other studies under the contract, however the delays have made it impossible to complete other studies on the planned schedule. (2) At the request of the sponsor, the distribution list for semi-annual reports and evaluation reports arising from the current contract has been substantially expanded, greatly increasing publication costs. (3) Scheduled reports from two of the three major sites being studied have not yet been received. We have been informed that the Chanute reports will be available late in February 1977. The Sheppard report is expected soon, but no date for its release has been given. The reports received have contained less information han had been expected. As a result, extra time has had to be spent by CERL personnel to recover or collect essential data.

We are now in the process of assembling a document to recommend which topics be reduced in scope or eliminated entirely. That report will be available in February.

## 1.2

## SUMMARY INFORMATION

For a detailed explanation of the following tables, see section 3.2 "Summary Information" in the Second Annual Report (1/1/74 - 12/31/74).

System usage is monitored by a sampling procedure which surveys every terminal once each hour that the system is in operation (including holidays, weekends, and test periods). This information is provided for use by the PEER group.

1.2.1

PLATO IV - Terminal Usage

July 1, 1976 - September 30, 1976

| User | Terminals September 1976 | Mean Hours per Week per Terminal | | | | | |
|---|---|---|---|---|---|---|---|
| | | July | | August | | September | |
| | | Prime | Total | Prime | Total | Prime | Total |
| CERL | 68 | 22.9 | 31.3 | 19.3 | 28.4 | 23.7 | 34.0 |
| U of I | 261 | 21.1 | 29.6 | 12.9 | 22.4 | 38.1 | 52.2 |
| Ill. Univ.'s | 129 | 19.6 | 22.8 | 14.1 | 16.9 | 16.8 | 19.8 |
| Other Univ.'s | 73 | 44.9 | 64.3 | 33.6 | 55.9 | 37.6 | 57.2 |
| Comm. Coll.'s | 119 | 23.8 | 23.8 | 13.9 | 13.9 | 30.1 | 30.3 |
| Schools | 65 | 0.3 | 0.3 | 0.7 | 0.7 | 3.2 | 3.2 |
| Government | 45 | 19.5 | 21.2 | 17.4 | 19.7 | 14.0 | 15.3 |
| Military | 87 | 26.3 | 28.9 | 19.6 | 21.5 | 16.0 | 17.5 |
| Commercial | 14 | 26.0 | 30.4 | 23.2 | 26.0 | 15.8 | 18.4 |

October 1, 1976 - December 31, 1976

| User | Terminals December 1976 | Mean Hours per Week per Terminal | | | | | |
|---|---|---|---|---|---|---|---|
| | | October | | November | | December | |
| | | Prime | Total | Prime | Total | Prime | Total |
| CERL | 63 | 27.1 | 37.3 | 23.1 | 36.4 | 19.9 | 30.8 |
| U of I | 259 | 37.9 | 50.0 | 28.2 | 43.7 | 23.3 | 37.6 |
| Ill. Univ.'s | 131 | 23.1 | 26.7 | 18.4 | 23.4 | 13.3 | 17.5 |
| Other Univ.'s | 69 | 39.3 | 59.7 | 32.5 | 56.1 | 26.2 | 46.0 |
| Comm. Coll.'s | 119 | 31.6 | 31.8 | 24.8 | 25.3 | 18.7 | 19.4 |
| Schools | 64 | 8.7 | 8.8 | 9.7 | 9.9 | 7.3 | 7.4 |
| Government | 48 | 19.5 | 22.2 | 17.0 | 20.2 | 15.2 | 19.0 |
| Military | 90 | 15.2 | 17.0 | 14.7 | 18.5 | 13.7 | 17.0 |
| Commercial | 11 | 22.1 | 25.8 | 13.8 | 16.7 | 14.2 | 18.3 |

ARPA Terminal Usage

July 1, 1976 - September 30, 1976

| User | Terminals September 1976 | Mean Hours per Week per Terminal | | | | | |
|---|---|---|---|---|---|---|---|
| | | July | | August | | September | |
| | | Prime | Total | Prime | Total | Prime | Total |
| ARPA-main | 1 | 51.1 | 51.6 | 26.3 | 27.8 | 8.6 | 12.6 |
| ARPA-CERL | 2 | 21.4 | 23.7 | 24.5 | 27.7 | 29.4 | 34.4 |
| ARI | 1 | 23.5 | 23.5 | 29.9 | 29.9 | 12.6 | 12.6 |
| Belvoir | 3 | 21.5 | 25.4 | 1.7 | 3.7 | 0.0 | 0.0 |
| Chanute | 30 | 40.6 | 45.7 | 24.5 | 27.7 | 13.5 | 13.6 |
| Eustis | 4 | 5.2 | 5.4 | 0.3 | 0.3 | 0.0 | 0.0 |
| HumRRO | 2 | 19.1 | 21.7 | 13.4 | 18.5 | 14.2 | 20.3 |
| Lowry | 7 | 10.1 | 10.9 | 11.2 | 12.8 | 8.3 | 10.0 |
| Monmouth | 1 | 66.6 | 78.7 | 49.8 | 58.4 | 41.7 | 42.7 |
| Orlando | - | 1.1 | 1.2 | -- | -- | -- | -- |
| ROTC | 1 | 13.9 | 14.7 | 0.3 | 0.3 | 26.1 | 39.5 |
| San Diego | 12 | 28.8 | 30.0 | 28.9 | 31.1 | 28.4 | 32.6 |
| Sheppard | 20 | 20.2 | 21.3 | 18.6 | 20.2 | 20.5 | 21.6 |
| USC | 2 | 2.6 | 2.6 | 1.4 | 1.5 | 1.3 | 2.2 |

October 1, 1976 - December 31, 1976

| User | Terminals December 1976 | Mean Hours per Week per Terminal | | | | | |
|---|---|---|---|---|---|---|---|
| | | October | | November | | December | |
| | | Prime | Total | Prime | Total | Prime | Total |
| ARPA-main | 1 | 13.2 | 13.2 | 2.6 | 2.6 | 3.3 | 3.3 |
| ARPA-CERL | 4 | 29.3 | 35.2 | 28.9 | 41.1 | 26.7 | 33.2 |
| ARI | 1 | 12.1 | 12.1 | 9.8 | 10.0 | 11.7 | 12.9 |
| Belvoir | 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Chanute | 30 | 13.2 | 13.3 | 13.1 | 13.9 | 12.3 | 13.1 |
| Eustis | 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| HumRRO | 3 | 8.4 | 13.8 | 13.7 | 23.3 | 11.4 | 18.1 |
| Lowry | 7 | 9.9 | 13.4 | 11.2 | 15.1 | 8.1 | 14.8 |
| Monmouth | 1 | 45.0 | 47.5 | 34.0 | 35.8 | 21.0 | 22.4 |
| ROTC | 1 | 27.8 | 34.8 | 34.0 | 64.7 | 35.1 | 53.0 |
| San Diego | 12 | 27.3 | 30.0 | 23.4 | 27.3 | 20.3 | 24.2 |
| Sheppard | 20 | 16.6 | 18.6 | 15.3 | 21.3 | 15.7 | 20.5 |
| USC | 2 | 2.8 | 8.6 | 14.4 | 20.6 | 21.2 | 29.6 |

1.2.3

PLATO IV System Performance*

(July 1, 1976 - December 31, 1976)

| | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|
| Mean hours to interruption | 23.55 | 15.62 | 16.42 | 9.31 | 13.93 | 23.05 |
| **Mean down time (hours) | .14 | .16 | .61 | .32 | .28 | .46 |
| Proportion of class hours interrupted once or more | .08 | .06 | .12 | .14 | .08 | .06 |
| Weeks to terminal Failure | 12.70 | 18.50 | 13.00 | 11.00 | 18.10 | 23.80 |
| Days to repair a terminal | 1.30 | 1.50 | 1.00 | 1.40 | 2.00 | 1.70 |
| % of terminal-hours usable | 97.40 | 97.80 | 92.20 | 94.50 | 96.40 | 97.00 |
| Terminal hours used | 92800 | 72900 | 103100 | 114100 | 106900 | 96000 |

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*Times are prime times for the indicated months. In general 70 to 80 hours were scheduled for such non-experimental use each week.

**Down time includes time required for 99% of users to return to normal operation.

1.2.4

## ARPA/PLATO PROJECT

Daniel Alpert - Director

| The MTC Group | The PEER Group |
|---|---|
| Larry Francis - Coordinator | R. Allen Avner - Chief |
| Eileen Call-Himwich | Esther Steinberg |
| Julie Garrard | Kumi Tatsuoka |
| Alec Himwich | Tamar Weaver |
| Joe Klecka | |
| Lynn Misselt | |

## 2. AUXILIARY MASS STORAGE

When fully implemented in the PLATO IV system the new eight megabyte memory, ordered from INTEL, will provide one million words of auxiliary storage at a transfer rate of 600 megabits per second. In this period a controller was designed to interface this memory to the existing extended core storage (ECS) in PLATO, and a high speed memory control format was defined to enable the PLATO system to use this new level of memory efficiently.

NOTE The memory was delivered and installed with its controller in early 1977. It has been successfully tested on PLATO, and will be installed permanently when systems software is complete.

P. Tucker

## 3. PORTABLE TERMINAL

A working bench model of the portable Plasma Display terminal was made operational in this period. The drive circuitry requires no floating power supplies, it requires only two components (diodes) per panel line, it uses a simple four transister, one power supply sustainer, and it requires only 75% of the power needed for present commercial circuitry.

P. Tucker

## 4. PLATO TERMINAL DEVELOPMENT

Development of the prototype PLATO terminal has been completed. A single printed circuit board version of the processor has been designed and is now installed in the terminal.

The terminal design will be used as the standard version of the next generation PLATO terminal. Request for bids on production models of the terminal are now being solicated.

System software is now being developed for operating these terminals in the PLATO system.

J. Stifle

## 5. AUDIO VISUAL FACILITY

A system for sharing three random-access audio devices among 12 plato IV terminals was designed, constructed and tested. It is now in use at the college of Veterinary Medicine. The complete description of the system, which was part of a Master's thesis, is given in "Microprocess-based Time Sharing System for use with the PLATO IV Random Access Audio Unit," by Dennis Stolarski, Urbana, Illinois.

The microprocessor-based time sharing system is designed to share three random-access audio units among twelve students. The system will operate with either the audios developed at the University of Illinois or the newer models manufactured by Education and Information Systems, Inc. Each participating terminal communicates with the microprocessor via the external output jack and the external input jack on the rear of PLATO IV terminals. When a message request is received by the time sharing system, the microprocessor interrogates the requesting terminal, reads the serial message address, and stores the data in memory. The processor then determines the availability of audio units. If all audio units are in use, the request is queued in a First In-first Out (FIFO) memory until such time an audio becomes available. A message is also sent to the terminals, via the external input, indicating the busy condition. If an audio is available, the message address is read from memory and serially sent to the appropriate audio unit. An audio switching matrix is also addressed to connect the audio channel to the requesting student's headsets.

There is another mode of operation in which the student can select a specific audio unit. In this mode, the system will search for the audio unit specified by the student. The same procedure for addressing and sending of the busy signal is used.

The first step of a two-step method for producing duplicate microfiche from one or more masters was designed, fabricated and tested, with satisfactory results. The second step has been designed, fabricated and is undergoing tests. Preliminary results are satisfactory.

Microfiche production using the step and repeat process continues as the rate of approximately 40/month.

D. Skaperdas

## 6. 9600 BIT PER SECOND MODEM DEVELOPMENT

The 9600 bit per second modem will allow eight PLATO Terminals to operate off a single telephone line. Presently there are only four terminals. Thus the 9600 baud modem will effectively cut telephone costs by half.

Development of the 9600 bps modem is practically completed. The receiver can now track and recover transmitted data over short distance telephone lines. Long distance transmission is not yet reliable due to phase equalization problems. A separate phase equalizer, which goes in line between the telephone line and receiver is being developed.

J. Teeter